

# **COST AND PERFORMANCE REPORT**

Soil Vapor Extraction  
at Sites 2 and 5 - Petroleum, Oils and Lubricants Area  
Holloman AFB, New Mexico

October 1998



**Prepared by:**  
U.S. Army Corps of Engineers  
Hazardous, Toxic, Radioactive Waste  
Center of Expertise

## SITE INFORMATION

### IDENTIFYING INFORMATION

**Site Name:** Sites 2 and 5 (Site 2/5)  
**Location:** Holloman AFB, New Mexico  
**Technology:** Soil Vapor Extraction (SVE)  
**Type of Action:** Remedial

Figure 1 shows the location of Holloman AFB in New Mexico.

### TECHNOLOGY APPLICATION (1,2)

**Period of Operation:** Full-scale operation - April 1995 through October 1998 (currently in operation)

**Quantity of Material Treated During Application:** 9,500 cubic yards of soil (contaminated zone is estimated to be 80 feet wide by 200 feet long by 16 feet deep). Soil treatment at Site 2/5 is ongoing.

### BACKGROUND

#### **Site Background (1,3,13):**

- Holloman AFB is located on 50,700 acres of land in Otero County in south-central New Mexico. The nearest population center is Alamogordo, which is located approximately 7 miles east of the base boundary. Holloman AFB was operated prior to World War II as a transitional flight training facility. The base was reactivated after WWII as a guided missile research and testing facility. In 1968, the base became host to the 49<sup>th</sup> Tactical Fighter Wing.
- An area surrounded by soil berms was previously used for storage of petroleum, oils and lubricants (POLs). This area included fourteen 25,000-gallon aboveground storage tanks (ASTs). The ASTs were used to store JP-4 jet fuel and diesel fuel and were removed in 1987.
- The former POL storage area was located on one-third of an acre in the northeastern portion of the main base area at Holloman AFB. Figure 2 shows the location of Site 2/5 at Holloman.

**SIC Code:** 9711 (National Security)

**Waste Management Practice that Contributed to Contamination:** Chronic and acute surface releases of JP-4 jet fuel, AVGAS, and diesel fuel from aboveground storage tanks.



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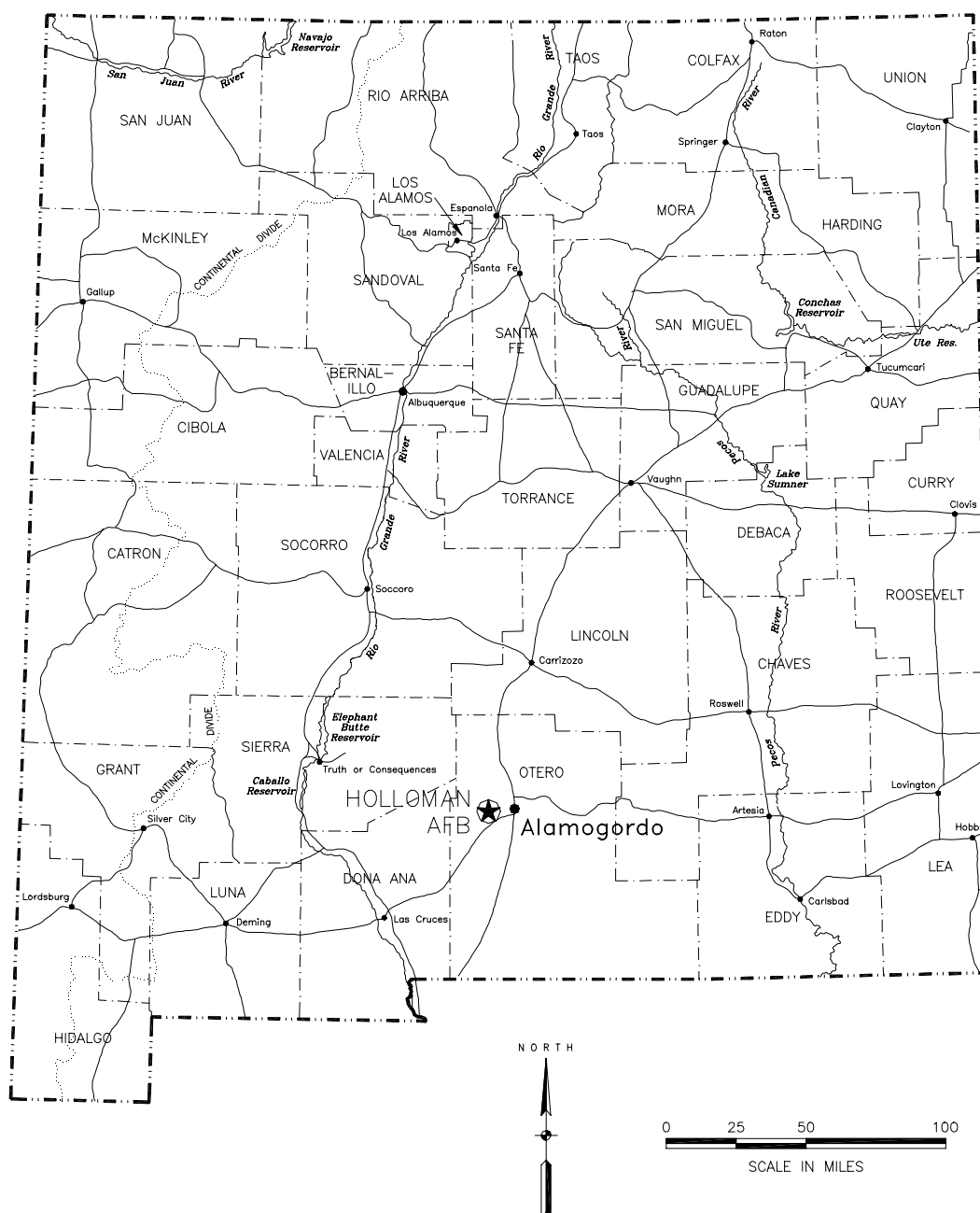


Figure 1. Location of Holloman AFB



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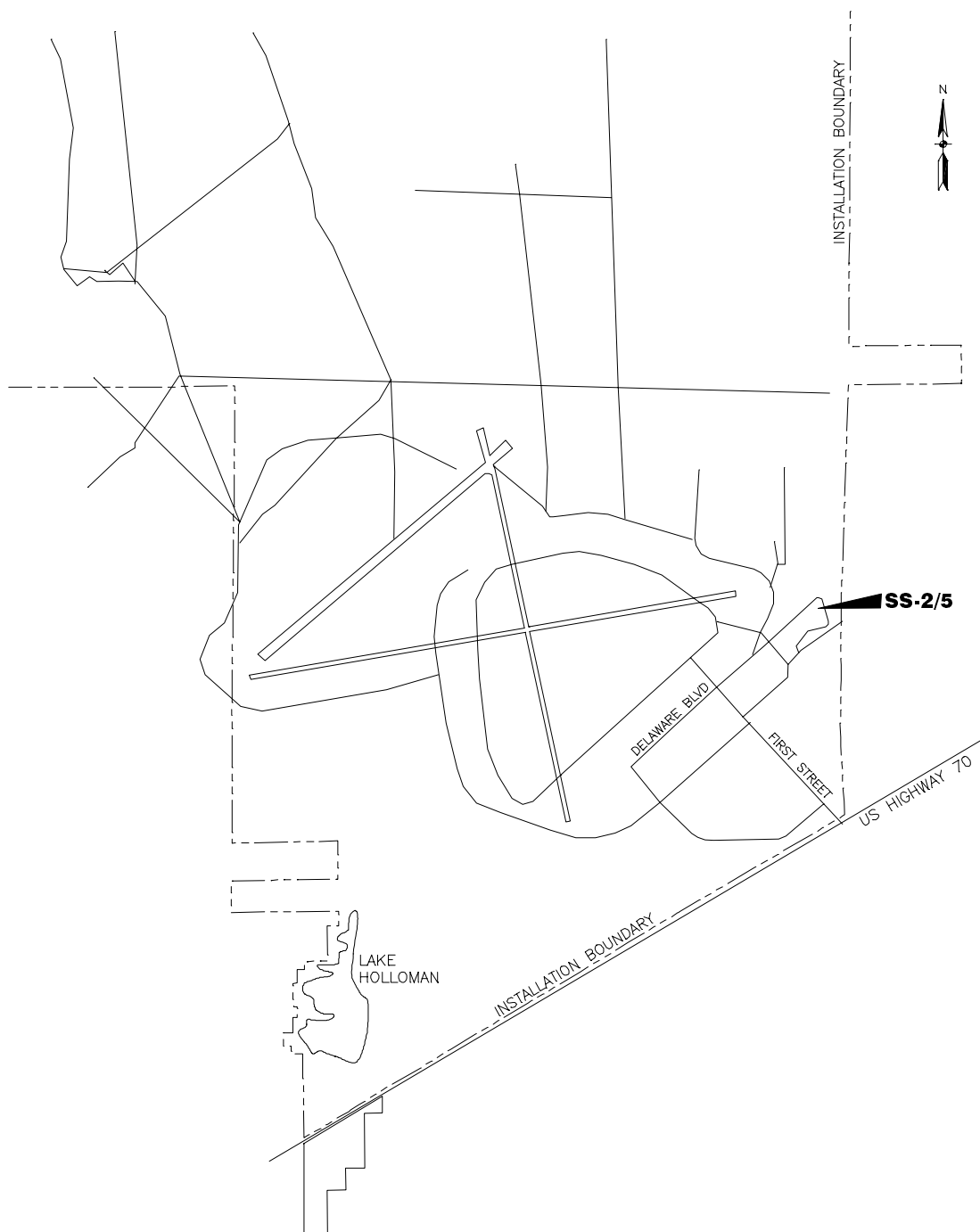


Figure 2. Location of Site 2/5 at Holloman AFB



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**Historical Activities Prior to Technology Application (3):**

- Periodic overtopping of the ASTs in the POL storage area caused several spills of JP-4 jet fuel and AVGAS in the 1960s and 1970s. The total volume of fuel spilled was not recorded. The areas around these spills were identified as POL Spill Site 1.
- In 1978, 30,000 gallons of JP-4 jet fuel was released into the bermed area around the ASTs. According to facility personnel, all but 1500 gallons of released fuel was recovered. The area around this spill was identified as POL Spill Site 2.
- In 1987, the 14 ASTs at IRP Site 2 (POL Spill Site 1) and Site 5 (POL Spill Site 2) were removed.

**Site Investigation (3,4,13):**

- An IRP Phase I Records Search was conducted for Holloman AFB in 1982 and 1983 (CH2M Hill, 1983). Sites 2 and 5 were identified separately in the Phase I report.
- In 1991 and 1992, a Remedial Investigation (RI) was performed and risk assessments were conducted for 29 sites at Holloman AFB, including Sites 2 and 5 (Radian, 1992). Sites 2 and 5 were combined into one site based on their close proximity to each other and similar nature. Risk assessments determined that three sites, including Site 2/5, would require remedial action. Investigation at Site 2/5 included completion of 16 soil borings and installation of 5 groundwater monitoring wells. Contaminants of concern at the site included petroleum hydrocarbons, especially benzene, toluene, ethylbenzene and xylenes (BTEX).
- In 1992, a Corrective Measures Study was performed for the 29 sites at Holloman AFB. Remedial Action Objectives (RAOs) were established for Holloman AFB in this plan. The New Mexico Environmental Department (NMED) recommended that all petroleum-contaminated sites at Holloman have soil clean up goals of 1000 mg/kg for Total Petroleum Hydrocarbons (TPH) and 25 mg/kg for benzene.
- In 1993, a Predesign Investigation (PDI) was performed at Site 2/5, including completion of 9 soil borings.
- In 1993, a feasibility study was performed for the three sites recommended for remediation (Radian, 1993). Alternatives considered for Site 2/5 included: No action; Containment (clay capping); In situ treatment (SVE/bioventing), In situ treatment (SVE/biosparging), Excavation/on-site treatment (low-temperature thermal treatment) and backfill with treated soil; and, Excavation and off-site disposal.
- In 1995, a Phase II RCRA Facility Investigation Report was issued for Table 1 SWMUs at Holloman AFB.
- In 1995, A Decision Document for Site 2/5 was issued. This document described the selected remedy (SVE), and long-term monitoring requirements for Site 2/5.
- A Final Characterization Study for Site 2/5 was submitted to NMED in March 1998. The site had not been officially closed as of October 1998.



## **SITE LOGISTICS/CONTACTS**

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## **MATRIX AND CONTAMINANT DESCRIPTION**

### **MATRIX IDENTIFICATION**

Soil (in situ)

### **SITE GEOLOGY/STRATIGRAPHY (1,3)**

- Holloman AFB is located within the Tularosa Basin in New Mexico. This basin is a bolson, which means that there is no surface drainage outlet from the basin. The bolson fill in the Tularosa Basin is derived from the erosion of limestone, dolomite and gypsum in the surrounding mountains. Coarser material is deposited at the base of the surrounding mountains; finer material is carried to the basin's interior. The near-surface bolson deposits consist of sediments that are of alluvial, eolian, and lacustrine or playa origin.
- Soil at Site 2/5 in the contaminated zone (down to 16 feet below ground surface (bgs)) is exclusively characterized as "sm" (USCS designation) according to soil borings completed at the site. The sm designation is described as: sand with fines; silty sands and sand-silt mixtures, which may be poorly graded; nonplastic. Site stratigraphy consists primarily of clean to silty sand deposits interbedded with silt and clay lenses.



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- Groundwater at Site 2/5 occurs in a shallow unconfined aquifer approximately 10 feet bgs. Despite this reported depth in the Holloman RI Report, the boring logs from the 22 wells installed for the SVE system indicated that the depth to groundwater was approximately 15 feet bgs in two wells, and deeper (groundwater not encountered) in the remaining wells. The primary groundwater flow direction at the site is to the northeast.
- The groundwater beneath Holloman AFB is designated as unfit for human consumption based on New Mexico Water Quality Control Commission regulations because it exceeds New Mexico Human Health Standards for total dissolved solids (TDS) and sulfates. Based on guidance provided under the EPA Groundwater Protection Strategy, the groundwater at Holloman was classified as III B. This classification indicates that the groundwater, by virtue of having a TDS concentration above 10,000 mg/L, is not considered a source or potential source of drinking water. In addition, Class III B groundwater is characterized by a low degree of interconnection with adjacent surface waters or groundwaters of a higher class.

### **CONTAMINANT CHARACTERIZATION**

Volatiles (nonhalogenated) – BTEX

### **CONTAMINANT PROPERTIES**

Contaminant properties are provided below for benzene, toluene, ethylbenzene, and xylene (BTEX).

Property	Units	Benzene	Toluene	Ethylbenzene	Xylenes
Chemical Formula	-	C <sub>6</sub> H <sub>6</sub>	C <sub>6</sub> H <sub>5</sub> CH <sub>3</sub>	C <sub>6</sub> H <sub>5</sub> C <sub>2</sub> H <sub>5</sub>	C <sub>6</sub> H <sub>4</sub> (CH <sub>3</sub> ) <sub>2</sub>
Molecular Weight	g/mole	78.11	92.14	106.17	106.17
Specific Gravity	-	0.88	0.87	0.87	0.86 - 0.88
Vapor Pressure	Mm Hg	95.2	28.1	7	10
Boiling Point	°C	80.1	110.6	136.2	138.3 - 144.4
Octanol-Water Partition Coefficient (K <sub>ow</sub> )	-	132	537	1,100	1,830
Soil-Water Partition Coefficient (K)	-	83	300	1,410	240

### **NATURE AND EXTENT OF THE CONTAMINANTS**

It is estimated that the extent of soil contamination at Site 2/5 is limited to a 80 foot wide by 200 foot long rectangular area, and that the contamination extends to a depth of 16 feet bgs at the site. Figure 3 shows the estimated area of contamination at Site 2/5. Soil samples collected during the RI were analyzed for metals using EPA SW-846 Methods 6010, 7060 and 7421, and were analyzed for organic compounds using EPA SW-846 Methods 418.1 and 8240. Metals were either not detected or were detected below applicable guidance levels in all samples, except for lead in one surface sample. Organic compounds and TPH were detected in most of the borings, and indicated the presence of petroleum-related contaminants in soil at the site. Results from organic compound analyses are discussed below.



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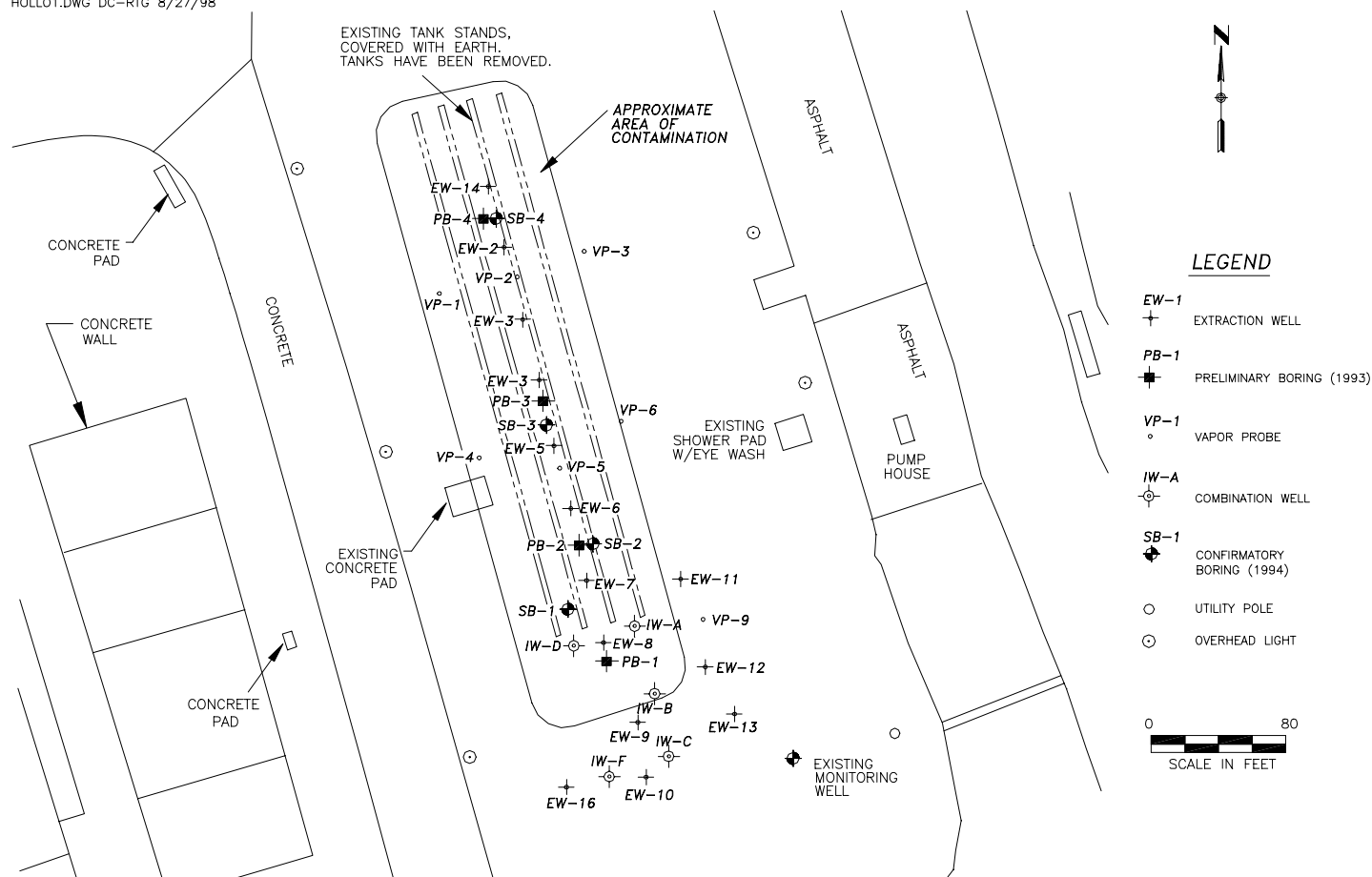


Figure 3. Layout of Site 2/5





**CHARACTERISTICS OF UNTREATED SOIL (1,3)**

- Soil samples were collected at Site 2/5 from 16 borings completed during the RI in 1991 and from 9 additional borings completed during a PDI performed in May 1993. Selected results (highest concentrations) from these borings are shown in Table C-1.
- The following table contains average pre-remediation concentrations for selected contaminants at Site 2/5. These concentrations were calculated using all soil sampling results generated for site 2/5 during the RI and PDI, including samples collected outside of the estimated area of contamination.

<b>Average Soil Concentrations from Borings Performed During the RI and PDI at Site 2/5</b>	
<b>Parameter</b>	<b>Average Concentration*</b>
Benzene	1,887 µg/kg
Toluene	11,824 µg/kg
Ethylbenzene	33,710 µg/kg
Xylene	62,362 µg/kg
TRPH	1,565 mg/kg

\*During calculation of average concentrations, it was assumed that all non-detect results were equal to zero.

- Soil samples were collected from four borings immediately prior to construction of the SVE system. Borings were located along the approximate lengthwise centerline of the 200-foot by 80-foot contaminated area. Each boring was sampled at 5 to 7 feet bgs, 10 to 12 feet bgs and 15 to 17 feet bgs. It has been speculated that the TRPH concentrations from this sampling event were anomalous. TRPH concentrations observed during this preliminary sampling event were significantly lower than concentrations detected after 17 months of SVE system operation. For the purposes of evaluating the performance of the SVE system, it was assumed that the initial average TRPH concentration in contaminated area at Site 2/5 was 3,000 mg/kg. This assumption is documented in Reference 10 to this report (The Operation and Maintenance Phase Final Engineering Report). Table C-2 shows the maximum concentrations and Unified Soil Classification System (USCS) description for each pre-construction boring.

**Table C-1. Characteristics of Untreated Soil (3,7)\***

<b>Boring ID (Depth)</b>	<b>Maximum Benzene Concentration Found (µg/kg)</b>	<b>Maximum Toluene Concentration Found (µg/kg)</b>	<b>Maximum Xylene (total) Concentration Found (µg/kg)</b>	<b>Maximum Ethylbenzene Concentration Found (µg/kg)</b>	<b>Maximum TRPH Contamination Found (mg/kg)</b>
SB-02&5-09 (15-17 ft bgs)	12,000	16,000	150,000	62,000	17,500
SB-02&5-12 (15-17 ft bgs)	48,000	210,000	450,000	180,000	5,220
SB-02&5-18 (16-18 ft bgs)	15,700	43,500	244,000	101,000	5,050
SB-02&5-19 (8-10 ft bgs)	1,060	41,900	332,000	87,000	5,600
SB-02&5-21 (6-8 ft bgs)	3,950	78,800	500,000	135,000	5,600

\*Results from selected samples collected during the RI and PDI.



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Table C-2. Characteristics of Untreated Soil (1)\*

Boring ID (Location)	Maximum Benzene Concentration Found (µg/kg)	Maximum Toluene Concentration Found (µg/kg)	Maximum Xylene (total) Concentration Found (µg/kg)	Maximum Ethylbenzene Concentration Found (µg/kg)	Maximum TRPH Contamination Found (mg/kg)	USCS Soil Type
PB-1 (south)	2,900	35,000	130,000	49,000	1,100	sm
PB-2 (south-central)	ND	21,000	79,000	48,000	970	sm
PB-3 (north-central)	24,000	45,000	130,000	59,000	890	sm
PB-4 (north)	1,000	35,000	35,000	65,000	1,400	sm

\*Results from samples collected immediately prior to startup of the SVE system.

ND – not detected

sm – sand with fines; silty sands and sand-silt mixtures, which may be poorly graded; nonplastic

### **MATRIX CHARACTERISTICS AFFECTING TREATMENT COST OR PERFORMANCE**

Soil Classification	USCS classification sm
Clay Content and/or Particle Size Distribution	Information not available
Moisture Content	Information not available
Air Permeability	Information not available
Porosity	Information not available
Total Organic Carbon	Information not available
Contaminant Sorption	Information not available
Presence of Inclusions	Information not available
Humic Content	Information not available

## **TREATMENT SYSTEM DESCRIPTION**

### **PRIMARY TREATMENT TECHNOLOGY**

#### **Soil Vapor Extraction**

### **SUPPLEMENTARY TREATMENT TECHNOLOGIES**

#### **Post-treatment (Water)**

A knockout tank is used to collect condensate from the extraction system prior to contacting the vacuum blower. Collected condensate is stored in 55-gallon drums and is disposed properly as necessary.

#### **Post-treatment (Air)**

In August 1997, a bioreactor was installed to treat a fraction of the vapor stream from the knockout tank. Prior to August 1997, treatment of the vapor stream from the SVE system was not performed at Site 2/5. It should be noted that treatment of the vapor stream from this system is not required by NMED. The bioreactor was installed as part of a research project conducted by New Mexico State University.



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Unfortunately, the unit did not function properly, and no meaningful vapor treatment performance data are available for the bioreactor.

### **TIMELINE (3,10)**

<b>Date</b>	<b>Activity</b>
1982-1983	CH2M Hill performed a Phase I Records Search for Holloman AFB.
1992	Radian Corporation performed a Remedial Investigation for Holloman and risk assessments for 29 sites at Holloman.
1993	Radian Corporation performed a Feasibility Study for three sites (including Site 2/5) at Holloman.
December 1994	IT Corporation began construction of the SVE system at Site 2/5 at Holloman. Construction included installation of 22 SVE/passive air vent wells.
March 1995	IT Corporation completed construction of the SVE system.
April 1995	IT Corporation began operation of the SVE system.
November 1996	IT Corporation completed 18 months of operation and maintenance (O&M) of the SVE system. Foster Wheeler took over the O&M on 1 November 1996.
August 1997	A bioreactor was installed to treat the vapor discharge stream from the SVE system (no vapor stream treatment had been used previously with the system).
March 1998	A Final Characterization Summary was submitted to NMED recommending that no further remedial action be taken at Site 2/5.

### **TREATMENT SYSTEM SCHEMATIC AND TECHNOLOGY DESCRIPTION AND OPERATION**

Figure 4 shows a simplified process flow diagram for the SVE system installed at Site 2/5.

#### **Mobilization (1)**

The contractor (IT Corporation) mobilized to the site on December 12, 1994. Mobilization included establishment of the project field office, surveying of proposed boring, vapor probe and well locations and inspection of all well installation equipment.

#### **Construction (1)**

- Sixteen (16) extraction wells, and six (6) combination extraction/passive vent wells were installed.
- Nine (9) soil vapor monitoring probe groups were installed to monitor the performance of the SVE system.
- Four (4) preliminary soil borings were installed to determine initial contaminant concentrations in site soil.

SVE system process piping, the 2-horsepower SVE blower, the knockout tank and a system control panel were installed. All of this equipment (other than the piping) was placed on an outdoor concrete slab surrounded by a fence.



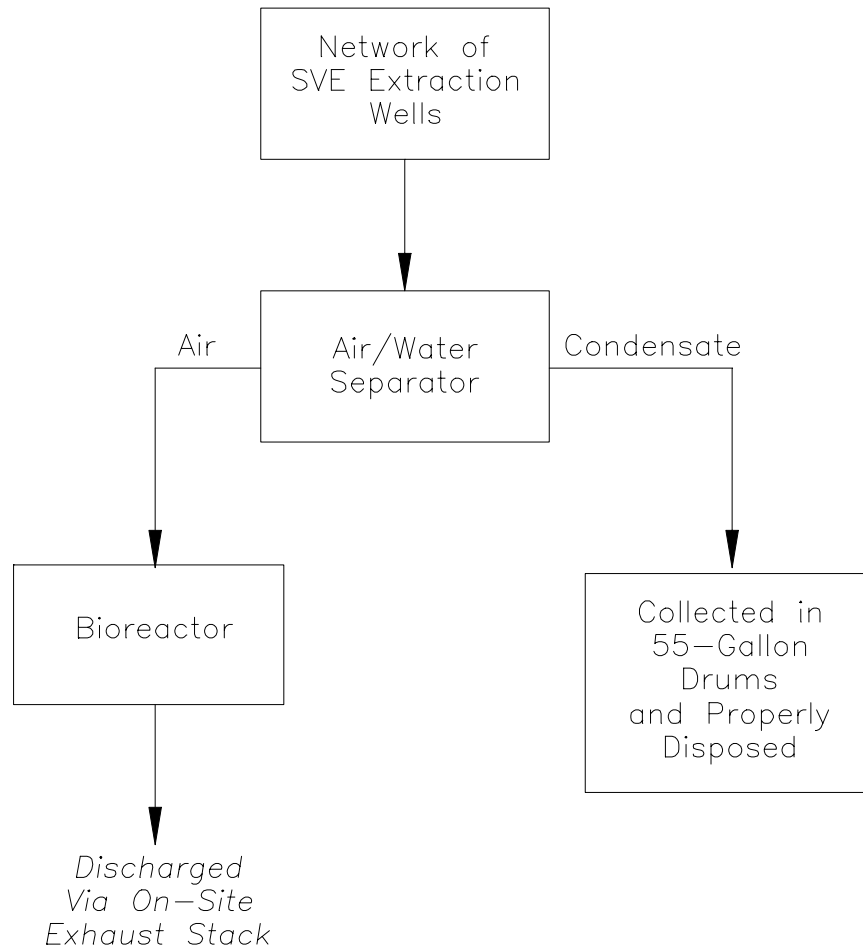


Figure 4. Treatment Process Flow Diagram for the SVE System at Site 2/5



- The system was tested prior to full-scale operation. Testing included:
  - Confirmation of system vacuum pressure, and methods of adjusting pressure (system inlet valve and fresh air bleed-in valve).
  - The volume of system exhaust was calculated and air samples were collected to determine system emissions;
  - Piping was visually and audibly inspected for leaks;
  - All system valves were checked for proper operation and for any leakage or obstructions; and
  - System alarms were set and tested.

#### Operation (10)

- The system was put into full-scale operation in April 1995 and is currently operating.
- The system experienced approximately 1.5 months of down time during the first three months of operation due to odor problems. These problems were addressed by raising the exhaust stack.
- The system experienced approximately 1.5 months of down time from October to December 1995 due to repeated rapid filling of the water collection tank. This problem was addressed by increasing the inspection schedule and emptying the collection tank more frequently.
- In July 1997, all 22 wells were converted to full extraction mode, and the system vacuum pressure was increased. These modifications were made to increase the contaminant removal rate of the system. The rate increase was possible because the system was operating well below New Mexico air emission guidelines (10 tons of VOCs allowed per year). It was determined that the system would be operated at a higher removal rate until site soil concentrations were below the guidance value of 1,000 mg/kg TPH, or until maximum allowable air emissions were achieved. Since July 1997, the well configuration has been modified several times. As of June 1998, 12 extraction wells were in use.
- In August and September 1997, a bioreactor (water-filled column) was installed to treat a fraction of the air stream from the SVE system. The bioreactor was installed by New Mexico State University. Prior to this time the air stream was not treated, as NMED did not require treatment. This unit did not function properly and is no longer in use.
- Throughout system operation, various extraction well configurations have been used. Prior to July 1997, the maximum number of extraction wells employed was 16. As many as 22 wells (all wells at the site) have been used for extraction since July 1997.



**OPERATING PARAMETERS AFFECTING TREATMENT COST OR PERFORMANCE (2,10)**

Air Flow Rate (typical)	70 standard cubic feet per minute (SCFM)
Operating Pressure/Vacuum (typical)	25.0 inches of water (since 11/96)
Operating Time	23,492 hours of operation through June 1998
Air Discharge Temperature (typical)	65-75 degrees Fahrenheit

**TREATMENT SYSTEM PERFORMANCE****PERFORMANCE OBJECTIVES**

- The soil cleanup goals for this application were developed based on the results of negotiations with the New Mexico Environmental Department (NMED).
- The negotiated cleanup goals for this application consist of the following:

TPH - 1000 mg/kg  
Benzene - 25 mg/kg  
Removal of floating free-phase hydrocarbons from groundwater

These are basewide goals for remedial activities at all POL sites.

- Groundwater at Holloman AFB was classified according the EPA Groundwater Protection Strategy. The groundwater was given a classification of III B (groundwater not a source of drinking water). Based on this classification, and because no floating free-phase hydrocarbons have been observed at the site, no groundwater cleanup goals were established for this site.

**TREATMENT PLAN**

No treatability studies or pilot tests were conducted prior to remediation at Site 2/5. SVE treatment was selected based on the recommendation of the December 1993 Feasibility Study.

**TREATMENT PERFORMANCE DATA (6,10)**

- Using data gathered prior to system startup, it was estimated that average soil TPH concentrations were 3,000 mg/kg prior to implementation of the SVE system. As mentioned previously, this assumption is documented in Reference 10 to this report. In September 1996, sampling indicated that the average soil TPH concentrations were approximately 1,600 mg/kg. As with the preliminary soil sampling event, samples were collected along the approximate centerline of the contaminated area. Data from the September 1996 sampling event are presented below in Table TPD-1.
- In September and October 1997, soil sampling was performed at Site 2/5 to determine if clean up criteria had been met. Sample locations were similar to those chosen for the 1994 and 1996 sampling events. In addition two borings (LT05 and LT06) were completed south of the main area of contamination. Results indicated that TPH concentrations at Site 2/5 had been reduced below 1,000 mg/kg (average TPH concentration was 150 mg/kg) and that benzene concentrations in soil remained below 25 mg/kg, as they have throughout the project. Table TPD-2 shows results from the 1997 sampling event. Figure 5 shows the sampling point locations for the 1996 and 1997 sampling events.



**Table TPD-1. Preliminary and Interim Confirmatory Soil Sampling Data at Site 2/5 [10]**

Boring ID (Location)	Depth Interval (feet bgs)		Benzene Concentration (ug/kg)		Toluene Concentration (ug/kg)		Xylene (total) Concentration (ug/kg)		Ethylbenzene Concentration (ug/kg)		TPH Concentration (ug/kg)	
Date/Boring ID	12/94	09/96	12/94	09/96	12/94	09/96	12/94	09/96	12/94	09/96	12/94*	09/96
SB-01 (south end)	5-7	4-8	ND	ND	9,100	ND	90,000	ND	27,000	120	1,100	244
	10-12	9.5-10.5	ND	ND	35,000	ND	44,000	38,000	13,000	6,500	490	945
	15-17	13-15	2,900	ND	27,000	ND	130,000	32,000	49,000	4,800	760	787
	NS	13-5 (dup)	NS	ND	NS	ND	NS	35,000	NS	5,300	NS	1,530
SB-02	5-7	5-6	ND	ND	21,000	ND	79,000	410	48,000	99	970	619
	10-12	9.5-10.5	ND	ND	6,900	ND	71,000	260,000	22,000	19,000	820	4,030
	15-17	14-15	ND	ND	5,900	ND	70,000	200,000	28,000	58,000	520	2,670
SB-03	5-7	4.5-5.5	ND	ND	14,000	ND	130,000	ND	26,000	ND	140	2,080
	10-12	10-11	ND	ND	6,300	ND	70,000	14,000	19,000	1,700	560	895
	15-17	13-15	24,000	ND	45,000	ND	130,000	110,000	59,000	33,000	890	1,640
SB-04 (north end)	5-7	4.5-5.5	ND	ND	4,100	ND	60,000	170	27,000	ND	390	440
	10-12	10-11	1,000	ND	18,000	ND	180,000	220,000	65,000	82,000	1,400	3,930
	15-17	14-15	810	2,300	6,400	5,800	50,000	75,000	19,000	26,000	480	962
	5-7(dup)	NS	ND	NS	1,700	NS	11,000	NS	4,600	NS	1,100	962

ND – Not Detected

NS – Not Sampled

\* - 12/94 results were determined to be anomalous for TPH. 3000 mg/kg TPH was assumed to be the initial soil concentration.

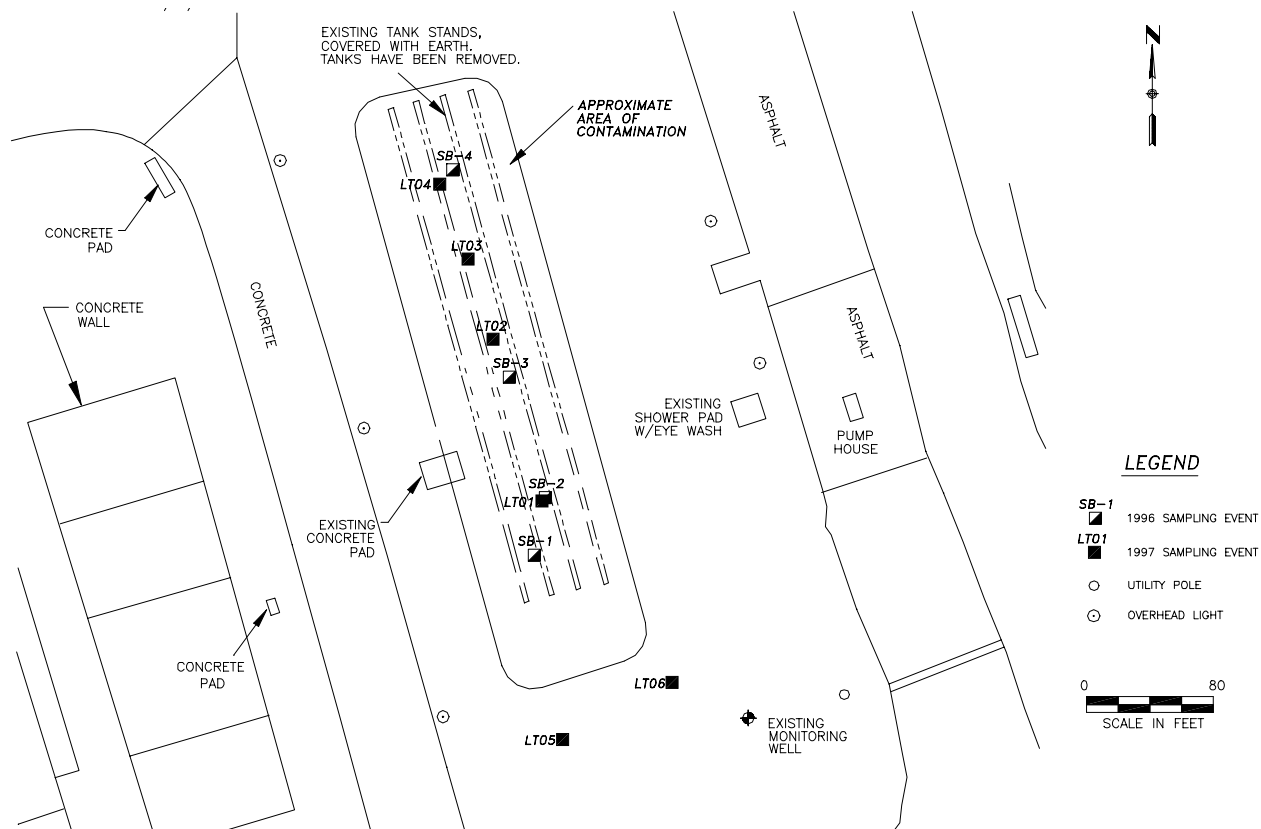


Table TPD-2. Final Confirmatory Soil Sampling Results (13)

Boring ID	Depth (feet bgs)	Benzene Concentration (mg/kg)	Toluene Concentration (mg/kg)	Ethylbenzene Concentration (mg/kg)	Xylene Concentration (mg/kg)	TPH Concentration (mg/kg)
LT01	10-11	ND	ND	ND	ND	390
	17-18	ND	ND	8.6	100.0	300
LT02	13-14	ND	ND	28.0	4.0	170
	16-17	ND	ND	ND	0.9	ND
LT03	12-13	1.1	9.9	72.0	254.0	220
	17-18	ND	0.7	6.5	16.9	67
LT04	11-12	ND	3.6	41.0	103.0	80
	16-17	9.1	65.0	190.0	379.0	130
LT05	11-12	ND	ND	ND	ND	ND
LT06	12.5-13.5	ND	0.4	5.7	60.0	150







NOTE: PREVIOUS BORINGS (PRIOR TO 1997) WITH SOIL TPH CONCENTRATIONS BELOW 1000 mg/kg ARE NOT SHOWN ON THIS FIGURE.

**Figure 5 - Confirmatory Sampling Locations**



Based on Monthly Project Metrics and Quarterly Project Status Reports generated throughout the course of the project, the following additional treatment performance data have been generated:

- The total estimated mass of TPH removed from the site (through December 1997) is 44,000 pounds (22 tons). This mass was calculated using results from air sampling of the exhaust stream from the SVE system.
- The monthly unit cost for TPH removal has varied from less than \$3 per pound removed to nearly \$21 per pound. The majority of the monthly unit costs have fallen between \$3 and \$6 per pound removed.
- As discussed earlier, average soil TPH concentrations at Site 2/5 have dropped from an estimated 3000 mg/kg to 150 mg/kg (October 1997). The clean up goal for the site is 1000 mg/kg. Sampling data indicate that benzene concentrations in site soil do not exceed the base-wide clean up goal of 25 mg/kg.
- The average monthly VOC concentrations in air emissions from the system were consistently near 1000 ppm from April 1995 through September 1996. In 1997, discharge concentrations varied from 1000 ppm to 4000 ppm due to various modifications to system operating parameters.
- The monthly O&M cost has typically varied between \$3000 and \$6000, with two sharply higher months in 1995 and 1996.
- The average TPH removal rate has typically varied between 2 and 3 pounds per hour.

**Material Balance:** A material balance cannot be performed for this application because initial contaminant volumes were not known. Removals can be estimated by using air emission concentrations, but there are no initial volumes for comparison and mass balance calculation.

**Removal Efficiencies (10,13):** At the time of the September 1996 interim sampling event, removal efficiencies were estimated by comparing VOC average concentrations with data gathered in December of 1994 (prior to system start up). Because TPH results from the December 1994 sampling event were considered anomalous, an initial TPH concentration of 3000 mg/kg was assumed. As mentioned previously, this assumption is documented in Reference 10 to this report. Based on these comparisons the following interim percent removals were achieved:

TPH	47%
Benzene	53%
Toluene	91%
Ethylbenzene	42%
Xylenes (total)	12%

Percent removals based on data gathered during the October 1997 sampling event are shown below. These percentages were also calculated using 3000 mg/kg as an initial concentration for TPH.

TPH	95%
Benzene	99%
Toluene	99%
Ethylbenzene	99%
Xylenes (total)	99%



## **PERFORMANCE DATA QUALITY**

It appears that a plan for sampling and analysis QA/QC was used for the confirmatory and initial sampling events at Site 2/5, including the collection of field duplicates, and the performance of typical laboratory QA/QC procedures. This plan was not available when this report was written.

## **TREATMENT SYSTEM COST**

### **PROCUREMENT PROCESS**

Details regarding the procurement process were not available for this project. IT Corporation was selected as the prime contractor for construction of the SVE system. The scope of work for IT also included performance of one year of treatment system O&M. The contract price for this project was \$548,046. In November 1996, after 18 months of system O&M, Foster Wheeler took over operation of the system. Foster Wheeler has performed system O&M from November 1996 through October 1998 (treatment ongoing). The mass of contaminants present at Site 2/5 has never been estimated, however, it has been estimated that 9500 cubic yards of soil were contaminated prior to commencement of remedial activities. Therefore, the bid cost can be converted to \$58 per cubic yard of contaminated soil.

### **TREATMENT SYSTEM COST (2,7)**

- Bid specifications and a scope of services were developed in August 1993 for the Holloman AFB Site 2/5 remediation project. The government estimate for the project was \$550,780. The project tasks included installation of the SVE treatment system and 12 months of system operation and maintenance (O&M).
- In 1993, IT Corporation was awarded a contract for \$548,046 to perform the Site 2/5 remediation project. It was estimated that \$343,000 of the cost was for construction of the system, and that 12 months of system O&M would cost \$205,000.
- Following 18 months of system operation (completed in September 1996), O&M was turned over to Foster Wheeler. From October 1996 through August 1997 the cost for system O&M has been approximately \$60,000, bringing the total project cost to approximately \$610,000. This has increased the unit cost for treatment to \$64 per cubic yard of contaminated soil.
- The costs for Site 2/5 remediation (soil vapor extraction) were categorized according to the HTRW Remedial Action Work Breakdown Structure (WBS), which includes specific cost elements for before-treatment activities, cost elements for activities directly attributed to treatment, and cost elements for after-treatment activities. Using the WBS, the costs for remediation at Site 2/5 were categorized as shown below in Table Cost 1.

**Table Cost 1. Summary of Costs for SVE Activities at Site 2/5  
Categorized According to the WBS (12)**

<b>WBS No.</b>	<b>Activity</b>	<b>Cost (\$)</b>	<b>Comment</b>
33-01 and 33-21	Mobilization and demobilization	34,884	Before treatment activities
33-02	Sampling and Analysis	21,941	Sampling ongoing
33-113-23	SVE installation costs	286,822	
33-113-23-02-08	SVE system O&M	267,000	Treatment ongoing



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## REGULATORY/INSTITUTIONAL ISSUES

According to facility personnel at Holloman AFB, no permits were required for installation and operation of the SVE treatment system. It was necessary for the system to meet applicable state requirements pertaining to operation, including allowable air emissions.

For the duration of this project, the state of New Mexico (NMED) has taken the lead in implementing closure of Site 2/5. The USEPA has been involved with the project, but mostly to provide concurrent review of plans and reports.

Site 2/5 clean up criteria are base-wide criteria previously developed for Holloman AFB. These criteria are:

- 1000 mg/kg TPH in soil;
- 25 mg/kg benzene in soil; and
- Removal of free-phase hydrocarbons from the groundwater surface.

Because benzene has never been detected above 25 mg/kg and free-phase hydrocarbons have not been observed in the groundwater at Site 2/5, only TPH removal was required at Site 2/5.

## OBSERVATIONS AND LESSONS LEARNED

### COST OBSERVATIONS AND LESSONS LEARNED

The awarded contract amount of \$548,046 can be converted to an estimated cost for treatment of \$58 per cubic yard of contaminated soil (9500 cubic yards to be treated). Based on the current cumulative project cost of approximately \$610,000, the treatment cost has increased to \$64 per cubic yard.

According to project personnel, equipment costs for the treatment system could have been reduced by substituting less expensive, painted PVC piping for fiberglass piping. It is unknown why fiberglass piping was used for this project.

### PERFORMANCE OBSERVATIONS AND LESSONS LEARNED

According to project personnel, the treatment system performance could have been improved by minimizing groundwater fluctuations at the site. Contaminant removal rates could have been increased by keeping the groundwater levels from rising significantly during periods of wet weather. A system of extraction wells could have been used to perform dewatering at the site.

In addition, field personnel have reported that the plastic sampling ports on the treatment system become degraded easily when exposed to direct sunlight, and require replacement.

## REFERENCES

- 1) Construction Phase Final Report, Site 2/5, POL Site Remediation, Holloman AFB, New Mexico, Prepared by IT Corporation, Denver, Colorado, August 1995.
- 2) Quarterly Project Status Report, April – September 1997, Sites 2 and 5/BX Service Station/Former Fire Training Area/POL Washrack/Officer's Club/T-38 Test Cell/Building 828/SWMU 136 Treatment System, Prepared by Foster Wheeler Environmental Corporation, Lakewood, Colorado, November 1997.



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- 3) Remedial Investigation Report, Investigation, Study and Recommendation for 29 Waste Sites, Prepared by Radian Corporation, October 1992.
- 4) Draft Final Feasibility Study, Investigation, Study and Recommendation for 29 Waste Sites, Prepared by Radian Corporation, December 1993.
- 5) RCRA Facility Investigation, Holloman Air Force Base, New Mexico, October 1994.
- 6) Project Metrix Update for Holloman Air Force Base, Prepared by Foster Wheeler Environmental Corporation, Lakewood, Colorado, September 1997.
- 7) Scope of Services for Contract No. DACW45-89-D-0504, Soil Vapor Extraction System, Site 2/5 & Infiltration well System, Site 57, Holloman AFB, New Mexico, August 1993.
- 8) Quarterly Project Status Report, January – March 1997, BX Service Station/ T-38 Test Cell /POL Washrack/Building 828/FT-31 Former Fire Training Area /Sites 2 and 5/Officer's Club Treatment Systems, Prepared by Foster Wheeler Environmental Corporation, Lakewood, Colorado, November 1997.
- 9) Cost Data for Innovative Treatment Technologies, Project Name: Sites 2 and 5, Soil Vapor Extraction System (SVE), Holloman AFB, Otero County, New Mexico, Prepared by the USACE, no date provided.
- 10) Operation and Maintenance Phase, Final Engineering Report, Site 2/5 POL Site Remediation, Holloman AFB, New Mexico, Prepared by IT Corporation, Denver, Colorado, March 1997.
- 11) Specifications (For Construction Contract), Attachment E, Site 2/5 POL Site Remediation, Prepared by the USACE, Omaha District, August 1993.
- 12) Facsimile communication from Rick Macfarlane (CESWA-CO-SA-H) to Jim Peterson (CEMRO-HX-T), Description of to date costs for Holloman AFB Site 2/5 project, November 1996.
- 13) Final Characterization Summary and No Further Action Documentation for IRP Sites SS-2/5 POL Yard (SWMU AOC-T), SD-47 POL Washrack Area (SWMU 133), and SS-60 Building 828 (SWMU 230), Prepared by Foster Wheeler Environmental Corporation, Lakewood, Colorado, March 1998.

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